UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/602,690	06/23/2000	Donald Brian Eidson	01827.0037.00US00	1643

7590 07/28/2004

HOWERY SIMON ARNOLD & WHITE, LLP
301Ravenswood Ave.
Box 34
Menlo Park, CA 94025

EXAMINER	
CHAUDRY, MUJTABA M	
ART UNIT	**PAPER NUMBER**
2133	

DATE MAILED: 07/28/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

Office Action Summary	**Application No.**	**Applicant(s)**	
	09/602,690	EIDSON ET AL.	
	Examiner	**Art Unit**	
	Mujtaba K Chaudry	2133	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *02 May 2004*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,2 and 4-51* is/are pending in the application.

4a) Of the above claim(s) *3* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,2 and 4-51* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1)☐ Notice of References Cited (PTO-892)

2)☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3)☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.

4)☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5)☐ Notice of Informal Patent Application (PTO-152)

6)☐ Other: _____.

DETAILED ACTION

Response to Amendment

Drawings

The purpose corrections to the drawings were received on May 20, 2004. These corrections are acceptable. However, Applicants are reminded to submit formal drawings showing corrections in subsequent response.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

- The term "prime polynomial" in claim 1 is a relative term which renders the claim indefinite since it is not defined over any specific field. The term "prime polynomial" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably appraised of the scope of the invention. The Examiner would like to point out that the issue of indefiniteness arises because a "primitive polynomial" is defined over some field. The claim language does not specify a field. For example the polynomial x2 + x + 1 is irreducible in GF(2)[x], but not in GF(4)[x]. Therefore, in order to overcome this issue, Applicants are advised to specify the field for the prime polynomial in the claim language. The amended claim does not overcome this previous rejection because the field over for the prime polynomial is still not defined. What is the *predetermined field?*

Appropriate correction is required.

Response to Arguments

Applicant's arguments/amendments with respect to pending claims 1-2 and 4-51 filed May 20, 2004 have been fully considered but are not persuasive. The Examiner would like to point out that this action is made final (See MPEP 706.07a).

In response to Applicants' argument that the references fail to show certain features of Applicants' invention, it is noted that the features upon which applicant relies (i.e., ...modulation mapping...) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993). Furthermore, in response to applicant's argument that modifying the encoder of Benedetto would destroy the modulation mapping associated with the n/n+1 encoder, the Examiner would like to point out that if the prior art structure is capable of performing the intended use, then it meets the claim. Also, the modulation mapping would not be destroyed but altered. In a claim drawn to a process of making, the intended use must result in a manipulative difference as compared to the prior art. See *In re Casey*, 152 USPQ 235 (CCPA 1967) and *In re Otto*, 136 USPQ 458, 459 (CCPA 1963).

In response to Applicants' argument that the references fail to show certain features of Applicants' invention, it is noted that the features upon which applicant relies (i.e., ...Euclidean distance...) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van*

Geuns, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993). Furthermore, in response to Applicants' argument that modifying the encoder of Benedetto would destroy the Euclidean distance associated with the n/n+1 encoder, the Examiner disagrees. The Euclidean distance would perhaps change but in no way would it be destroyed. The Examiner would also like to point out that the arguments presented by the Applicants imply that only by modifying the teachings of Benedetto by removing output Xo would be the only change necessary. However, one of ordinary skill in the art would know that modulation mapping would obviously be altered. The reason why this is not the issue here is because the claims of the present application are broad and do not particularly limit the scope by defining what modulation mapping is used. If the prior art structure is capable of performing the intended use, then it meets the claim. In a claim drawn to a process of making, the intended use must result in a manipulative difference as compared to the prior art. See *In re Casey*, 152 USPQ 235 (CCPA 1967) and *In re Otto*, 136 USPQ 458, 459 (CCPA 1963).

Applicants' arguments fail to comply with 37 CFR 1.111(b) because they amount to a general allegation that the claims define a patentable invention without specifically pointing out how the language of the claims patentably distinguishes them from the references.

Furthermore, Applicants' arguments do not comply with 37 CFR 1.111(c) because they do not clearly point out the patentable novelty which he or she thinks the claims present in view of the state of the art disclosed by the references cited or the objections made. Further, they do not show how the amendments avoid such references or objections.

The Examiner disagrees with the Applicants and maintains rejections with respect to pending claims 1-2 and 4-51. All arguments have been considered. It is the Examiner's conclusion that claims 1-2 and 4-51 are not patentably distinct or non-obvious over the prior art of record. See previous rejection below.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 1-42 and 48-51are rejected under 35 U.S.C. 103(a) as being unpatentable over **Turbo Codes: Analysis, Design and Iterative Decoding and Applications** Course 909, by Benedetto et al. further in view of Divsalar et al. (USPN 6023783). As stated above, due to multiple dependencies, claims 43-47can not be examined on the merits.

As per claim 1, Benedetto et al. (herein after: Benedetto) substantially teaches the limitations in claim 1 of the present application through Figure 3, page 295; Figure 4, page 300

and Figure 8, page 339. Claim 1 of the present application recites: A rate n/n recursive, systematic convolutional encoder which comprises: n inputs, wherein n is an integer greater than 1; n parallel outputs; an adder having (n+1) inputs and an output; and a feedback loop, including one or more storage elements in series, coupled to the output of the adder and to an input thereof, the feedback loop and the one or more storage elements being characterized by a prime polynomial; wherein all n encoder inputs are input to the adder, (n-1) of the encoder inputs are passed through unaltered to form (n-1) of the encoder outputs, and the nth encoder output is derived from the feedback loop. The following figure is imported from Benedetto's reference.

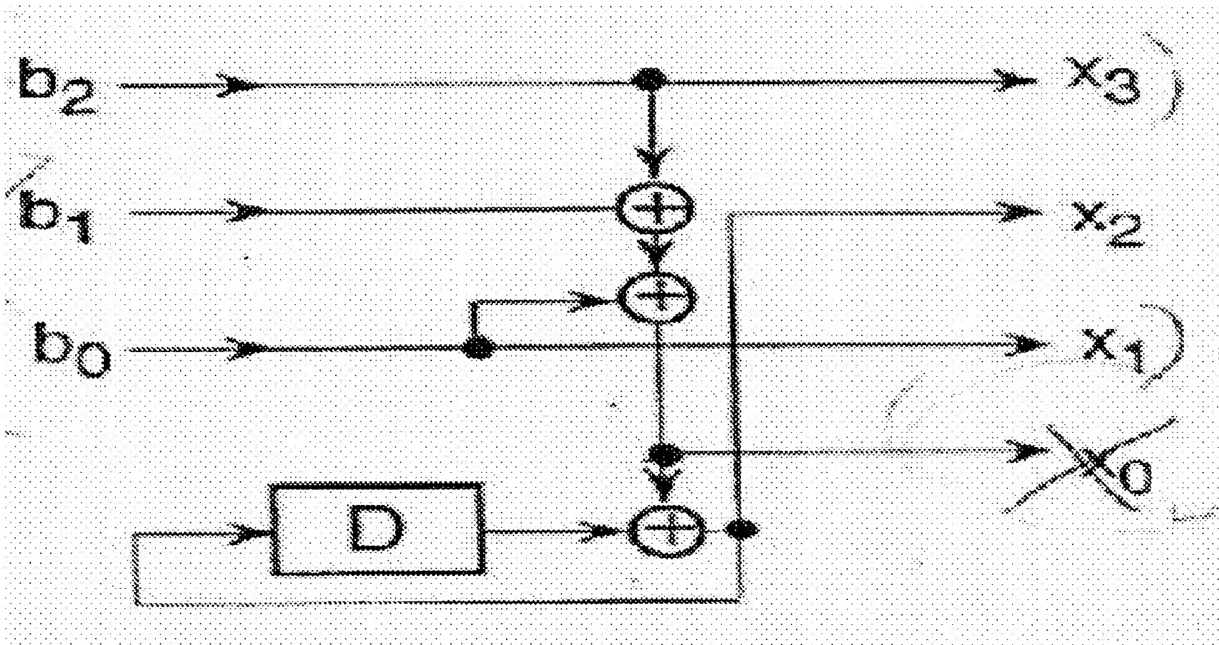

Figure 4, Page 300

The Examiner would like to point out that in the above Figure 4, Benedetto teaches the limitations of claim 1 with slight modification. The following description is in reference to Figure 4 above: The adder connected to the output of the delay element has (n+1) inputs, which are b2, b1, b0 and the output of the adder. The output of the adder in formed in a feedback loop

that includes a storage element. Furthermore, two of the three inputs of the encoder are unaltered, namely b2 and b0, whose respective outputs are x3 and x1.

Benedetto does not explicitly teach a rate n/n encoder as stated in the present application. The Examiner would like to point out that it is well know in the art that a rate of an encoder is defined as the ratio of the number of inputs to outputs. The limitation of claim 1 of the present application states a rate n/n, which essentially means that the number of inputs is equal to the number of outputs. Referring to Benedetto's Figure 4 above, one of ordinary skill in at the time the invention was made would have recognized that by eliminating output x0 would indeed have made the above-shown encoder a rate n/n. This modification would have been obvious to one of ordinary skill in the art because one of ordinary skill in the art would have recognized that by eliminating the x0 output of the encoder taught by Benedetto in Figure 4 would have increased the coding gain at relatively low bit error rates. Furthermore, the Examiner would like to add that by removing the x0 output also would have been an obvious design choice and not patentably distinct.

As per claims 2-3, Benedetto substantially teaches, in view of above rejections and Figure 4 above, a feedback loop that includes a single storage element wherein the input of the storage element is coupled to the output of the adder, and the output of the storage element is coupled to an input of the adder, and the nth encoder output is derived from the output of the storage element.

As per claims 4-8 and 11-19, Benedetto substantially teaches, in view of above rejections, a rate n/n encoder which could be modified to a rate 2/2, 3/3, 4/4, 5/5 or greater. This is an engineering design choice which could easily be modified.

As per claims 9, 10 and 32-35, Divsalar et al. (herein after: Divsalar) in an analogous art teaches (title & abstract) several improved turbo code apparatuses and methods. The Divsalar patent encompasses several classes: A data source is applied to two or more encoders with an interleaver between the source and each of the second and subsequent encoders. Each encoder outputs a code element which may be transmitted or stored. A parallel decoder provides the ability to decode the code elements to derive the original source information d without use of a received data signal corresponding to d. The output may be coupled to a multilevel trellis-coded modulator (TCM). A data source d is applied to two or more encoders with an interleaver between the source and each of the second and subsequent encoders. Each of the encoders outputs a code element. In addition, the original data source d is output from the encoder. All of the output elements are coupled to a TCM. At least two data sources are applied to two or more encoders with an interleaver between each source and each of the second and subsequent encoders. The output may be coupled to a TCM. At least two data sources are applied to two or more encoders with at least two interleavers between each source and each of the second and subsequent encoders. At least one data source is applied to one or more serially linked encoders through at least one interleaver. The output may be coupled to a TCM. The invention includes a novel way of terminating a turbo coder. In particular Divsalar substantially teaches (col. 22, lines 43-67), in view of above rejections, methods that are equivalent to a multidimensional trellis-coded modulation scheme that uses 2.sup.b/2 .times.2.sup.1+b/2 symbols per branch, where the first symbol in the branch (which depends only on uncoded information) is punctured. With these methods, the reliability of the punctured symbols can be fully estimated at the decoder. The constituent codes for a given modulation could be redesigned based on the

Euclidean distance. The first example is for b=2 with 16 QAM modulation where, for simplicity, we can use the 2/3 codes in Table I above with Gray code mapping. Note that this may result in suboptimum constituent codes for multilevel modulation. A turbo encoder with 16 QAM and two clock-cycle trellis termination is shown in FIG. 21.

As per claims 20-30, 36, 37 and 48-52, Divsalar substantially teaches (col. 22, lines 1-63), in view of above rejections, various embodiments for Tellis Code Modulation (TCM). For example, for a q=2 turbo code with rate b/(b+1) constituent encoders, select the b/2 systematic outputs and puncture the rest of the systematic outputs, but keep the parity bit of the b/(b+1) code (note that the rate b/(b+1) code may have been obtained already by puncturing a rate 1/2 code). Then do the same to the second constituent code, but select only those systematic bits that were punctured in the first encoder. This method requires at least two interleavers: the first interleaver permutes the bits selected by the first encoder and the second interleaver permutes those bits punctured by the first encoder. For MPSK (or M-QAM), we can use 2.sup.1+b/2 PSK symbols (or 2.sup.1+b/2 QAM symbols) per encoder and achieve throughput of b/2. For M-QAM, we can also use 2.sup.1+b/2 levels in the I-channel and 2.sup.1+b/2 levels in the Q-channel and achieve a throughput of b bits/s/Hz. These methods are equivalent to a multidimensional trellis-coded modulation scheme (in this case, two multilevel symbols per branch) that uses 2.sup.b/2 .times.2.sup.1+b/2 symbols per branch, where the first symbol in the branch (which depends only on uncoded information) is punctured. Now, with these methods, the reliability of the punctured symbols can be fully estimated at the decoder. The constituent codes for a given modulation should be redesigned based on the Euclidean distance. The first example is for b=2 with 16 QAM modulation where, for simplicity, we can use the 2/3 codes in Table I above with

Gray code mapping. Note that this may result in suboptimum constituent codes for multilevel modulation. A turbo encoder with 16 QAM and two clock-cycle trellis termination is shown in FIG. 21. The BER performance of this code with the turbo decoding structure for two codes discussed above is given in FIG. 22. For permutations .pi..sub.1 and .pi..sub.2, we used S-random permutations with S=40 and S=32, with a block size of 16,384 bits. Throughput was 2 bits/s/Hz. For 8 PSK modulation, we used two 16-state, rate 4/5 codes given above to achieve a throughput of 2 bits/s/Hz. The parallel concatenated trellis codes with 8 PSK and two clock-cycle trellis termination is shown in FIG. 23. The BER performance of this code is given in FIG. 24. For 64 QAM modulation, two 16-state were used, rate 4/5 codes given above to achieve a throughput of 4 bits/s/Hz. The parallel concatenated trellis codes with 64 QAM and two clock-cycle trellis termination is shown in FIG. 25. The BER performance of this code is given in FIG. 26. For 8 PSK modulation, we used two 16-state, rate 4/5 codes given above to achieve a throughput of 2 bits/s/Hz. The parallel concatenated trellis codes with 8 PSK and two clock-cycle trellis termination is shown in FIG. 23. The BER performance of this code is given in FIG. 24. A turbo encoder with 16 QAM and two clock-cycle trellis termination is shown in FIG. 21. FIG. 23 is a block diagram of an 8 PSK turbo trellis-coded modulation coder in accordance with the present invention. The Examiner would like to point out that with the combination of the teachings of Divsalar with Benedetto the various embodiments of the above claims are established.

As per claims 31 and 38-42, Divsalar substantially teaches (col. 22, lines 1-63), in view of above rejections, various embodiments for Tellis Code Modulation (TCM). Divsalar teaches FIG. 28, a block diagram showing a general iterative decoder structure for the TCM encoded

output of, for example, FIGS. 21, 23, and 25. Furthermore, Divsalar teaches a method to construct Turbo TCM. As stated before, for a q=2 turbo code with rate b/(b+1) constituent encoders, select the b/2 systematic outputs and puncture the rest of the systematic outputs, but keep the parity bit of the b/(b+1) code (note that the rate b/(b+1) code may have been obtained already by puncturing a rate 1/2 code). Then do the same to the second constituent code, but select only those systematic bits that were punctured in the first encoder. This method requires at least two interleavers: the first interleaver permutes the bits selected by the first encoder and the second interleaver permutes those bits punctured by the first encoder. For MPSK (or M-QAM), we can use 2.sup.1+b/2 PSK symbols (or 2.sup.1+b/2 QAM symbols) per encoder and achieve throughput of b/2. For M-QAM, we can also use 2.sup.1+b/2 levels in the I-channel and 2.sup.1+b/2 levels in the Q-channel and achieve a throughput of b bits/s/Hz. These methods are equivalent to a multidimensional trellis-coded modulation scheme (in this case, two multilevel symbols per branch) that uses 2.sup.b/2 .times.2.sup.1+b/2 symbols per branch, where the first symbol in the branch (which depends only on uncoded information) is punctured. Now, with these methods, the reliability of the punctured symbols can be fully estimated at the decoder. Obviously, the constituent codes for a given modulation should be redesigned based on the Euclidean distance. The first example is for b=2 with 16 QAM modulation where, for simplicity, we can use the 2/3 codes in Table I above with Gray code mapping. Note that this may result in suboptimum constituent codes for multilevel modulation. A turbo encoder with 16 QAM and two clock-cycle trellis termination is shown in FIG. 21. The BER performance of this code with the turbo decoding structure for two codes discussed above is given in FIG. 22. For permutations .pi..sub.1 and .pi..sub.2, we used S-random permutations

with S=40 and S=32, with a block size of 16,384 bits. Throughput was 2 bits/s/Hz. For 8 PSK modulation, we used two 16-state, rate 4/5 codes given above to achieve a throughput of 2 bits/s/Hz. The parallel concatenated trellis codes with 8 PSK and two clock-cycle trellis termination is shown in FIG. 23. The BER performance of this code is given in FIG. 24. For 64 QAM modulation, we used two 16-state, rate 4/5 codes given above to achieve a throughput of 4 bits/s/Hz. The parallel concatenated trellis codes with 64 QAM and two clock-cycle trellis termination is shown in FIG. 25. The BER performance of this code is given in FIG. 26. In FIG. 27, Divsalar teaches a application of a TCM module M in combination with a conventional two-code turbo coder to give the advantages noted above. In addition, such a module M is shown in outline in FIGS. 6 and 7. It should be noted that the structures shown in FIGS. 6, 7, and 27 are general in nature, and provide advantages independent of specific interleavers, coders, and TCM modules.

Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event,

however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Any inquiries concerning this communication should be directed to the examiner, Mujtaba Chaudry who may be reached at 703-305-7755. The examiner may normally be reached Mon – Thur 7:30 am to 4:30 pm and every other Fri 8:00 am to 4:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, please contact the examiner's supervisor, Albert DeCady at 703-305-9595. The fax phone number for the organization where this application is assigned is 703-746-7239.

Any inquiry of general nature or relating to the status of this application or proceeding should be directed to the receptionist at 703-305-3900.

Mujtaba Chaudry
Art Unit 2133
July 13, 2004

ALBERT DECADY
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2100